THE PHYSICS QUESTION BANK · AQA GCSE PHYSICS

Keep the Country Running – The National Grid

A one-hour lesson. Find out how the National Grid gets electricity to you without wasting it – then run the grid control room for a day.

Name: _____ Class: _____ Date: _____

How to use this worksheet: work through the steps in order and write your answers in your exercise book. Copy every blue 📝 box neatly – these are your revision notes. When you have finished a step, check your work against the **Answers** at the end and correct anything in a different colour.

📝 **COPY INTO YOUR BOOK**

By the end of this lesson I will be able to:

1. describe the National Grid

2. explain why step-up and step-down transformers are used

3. use P = VI and P = I²R to show why a high p.d. wastes less energy

4. explain how the grid meets changing demand.

Step 1: Starter (5 minutes)

Plug sockets are at about 230 V, but pylon cables carry electricity at up to 400 000 V. **Why do you think it's sent at such a high potential difference?**

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High p.d. → low current → less energy wasted heating the cables.

Step 2: Read and write (8 minutes)

Copy these three questions into your book. Then read the text and answer them in full sentences.

1. What is the National Grid?
2. What does a step-up transformer do, and where is it?
3. What does a step-down transformer do, and why is it needed?

📖 **READ**

Getting electricity from power station to home

The **National Grid** is a system of cables and transformers that links power stations to homes, schools and businesses (consumers) all over the country.

Electricity leaving a power station goes through a **step-up transformer**. This increases the potential difference to a very high value – up to 400 000 V – and decreases the current. A lower current means much less energy is lost heating the cables, so the system is more efficient. Before the electricity reaches homes, **step-down transformers** decrease the potential difference to about 230 V, which is much safer to use.

📝 **COPY AND COMPLETE**

The National Grid is a system of _____ and _____ that links _____ _____ to consumers. A step-_____ transformer increases the p.d. A step-_____ transformer decreases it to about _____ V for homes.

Step 3: Key facts (5 minutes)

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Step-up transformer increases p.d.

→ so the current in the cables is smaller (P = VI)

→ so less energy is wasted heating the cables ($P = I^2R$)

→ so transmission is more efficient.

Demand for electricity changes during the day. It's lowest overnight and highest in the early evening. Some power stations (like nuclear) produce a steady output and are slow to change; others (like hydro-electric and pumped storage) can respond in minutes.

Step 4: Prove it with a calculation (10 minutes)

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power = potential difference × current $P = V\ I$

power wasted in a cable = current² × resistance $P = I^2\ R$

A village needs **100 000 W** of power. The cable to the village has a resistance of **5 Ω**. Show every step.

Q1 If the power is sent at 1000 V, what is the current in the cable?

Q2 How much power is wasted heating the cable?

Q3 A step-up transformer increases the p.d. to 25 000 V. Work out the new current and the power wasted.

Q4 In one sentence, explain what your answers show.

Step 5: Main task – Grid Control Room (12 minutes)

You're in charge of the grid control room today! Demand on a winter weekday:

Time	Demand	What's happening
4 am	20 GW	Most people asleep
8 am	32 GW	Breakfast, heating, getting ready
6 pm	38 GW	Cooking, lights, TVs – the daily peak
8:45 pm	+1 GW in a few minutes	Half-time in a big football match – kettles go on!

Power station	How fast can it change output?	Other notes
Nuclear	Very slowly – best run steadily	No CO_2; reliable
Gas	About an hour to start	Releases CO_2; reliable
Hydro-electric / pumped storage	In minutes	No CO_2; limited stored water
Wind	Can't be controlled	No CO_2; unreliable

Your task: write a three-part plan. 1. All day (base load): which power stations run all the time, and why? 2. Morning and evening peaks: which do you add, and when must you switch them on? 3. Half-time surge: which do you use, and why is it the only option?

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Demand for electricity changes during the day. Steady power stations (like nuclear) supply the base load. Hydro-electric and pumped storage can respond to sudden surges within minutes.

Step 6: Exam practice (12 minutes)

Q1 (2 marks) Why is a step-down transformer used before electricity reaches homes?

Q2 (3 marks) A power station supplies 500 MW to the grid at 400 000 V. Calculate the current in the cables.

Q3 (4 marks) Explain how the National Grid uses transformers to make the transmission of electricity efficient.

✅ Add up your marks out of 9.

Step 7: Exit ticket (5 minutes)

- Electricity is sent at a high p.d. because…
- At half-time, the grid uses… because…
- One thing I'm still not sure about is…

Answers

Only look at these once you have written your own answer!

Step 1: Starter (5 minutes)

A high p.d. means a low current is needed to transfer the same power. A low current heats the cables less, so less energy is wasted.

Step 2: Read and write (8 minutes)

(1) A system of cables and transformers linking power stations to consumers. (2) Increases the p.d. (and decreases the current) – between the power station and the transmission cables. (3) Decreases the p.d. to a safer level for homes (about 230 V).

Gaps: cables · transformers · power stations · up · down · 230

Step 4: Prove it with a calculation (10 minutes)

Q1 I = 100 000 ÷ 1000 = 100 A. Q2 P = $100^2 \times 5$ = 50 000 W (half is wasted!). Q3 I = 100 000 ÷ 25 000 = 4 A; P = $4^2 \times 5$ = 80 W. Q4 A higher p.d. makes the current much smaller, and because wasted power depends on current squared, far less energy is wasted.

Step 5: Main task – Grid Control Room (12 minutes)

1. Nuclear runs steadily all day (can't change quickly, no CO_2); wind used whenever available. 2. Gas switched on about an hour before the 8 am and 6 pm peaks (takes an hour to start). 3. Hydro-electric / pumped storage – the only option that responds within minutes.

Step 6: Exam practice (12 minutes)

Q1: It decreases the p.d. (1) to a safer level for homes (1).

Q2: 500 MW = 500 000 000 W (1); I = 500 000 000 ÷ 400 000 (1); I = 1250 A (1).

Q3: Step-up transformers increase the p.d. (1); so the current is smaller for the same power (1); so less energy is lost heating the cables (1); step-down transformers reduce the p.d. to a safe level for consumers (1).